California Environmental Protection Agency

Air Resources Board

Pleasure Craft Evaporative Emissions Test Procedure

TP-1502

Test Procedure for Determining Permeation Emissions From Pleasure Craft Fuel Tanks

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TP-1502
TABLE OF CONTENTS

LIST OF FIGURES

California Environmental Protection Agency
Air Resources Board
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A set of definitions common to all Certification and Test Procedures are in Title 13, California Code of Regulations (CCR), section 2752 et seq.

For the purpose of this procedure, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer, or his or her authorized representative or designate.

1. APPLICABILITY

This Test Procedure, TP-1502, is used by the Air Resources Board to determine the permeation rate from fuel tanks. This Test Procedure is proposed pursuant to section 43824 of the California Health and Safety Code (CH&SC) and is applicable in all cases where fuel tanks subject to the permeation design standard are sold, supplied, offered for sale, or manufactured for use in the State of California.

1.1 Requirement to Comply with All Other Applicable Codes and Regulations

Certification or approval of a pleasure craft fuel tank by the Executive Officer does not exempt the fuel tank from compliance with other applicable codes and regulations such as state and federal safety codes and regulations.

1.2 Safety

This test procedure involves the use of flammable materials and operations and should only be used by or under the supervision of those familiar and experienced in the use of such materials and operations. Appropriate safety precautions should be observed at all times while performing this test procedure.

2. PERFORMANCE STANDARDS

The minimum design standards for certification of evaporative emission control systems on pleasure craft are defined in CCR Title 13, Chapter 9, Article 4, section 2791.1.

3. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The fuel tank is filled to its nominal capacity with California Reformulated Gasoline Phase III (CFGIII) fuel and all outlet(s) are sealed. Once the fuel tank is sealed, it is allowed to precondition at ambient temperature and pressure for a minimum of 20 weeks or until

equilibrium is reached. Once preconditioning is complete, the tank is emptied and immediately refilled with CFGIII at room temperature.

The fuel tank is then placed into a temperature controlled enclosure with all tank openings unsealed. The enclosure temperature is brought up to 40°C and allowed to equilibrate for a minimum of eight hours. Once the equilibration is reached, the tank is sealed and a 10 day test is conducted at 40°C. The tank is weighed initially and at least daily for 10 consecutive days. A graph is plotted of the cumulative daily weight loss against the sampling time. At the conclusion of 10 days, the permeation rate is calculated. The permeation rate is calculated by dividing the slope of the regression line of the graph divided by the tank's internal surface area.

4. BIASES AND INTERFERENCES

To accurately quantify the losses attributable solely to permeation, each tank tested must be completely sealed. Tanks incorrectly sealed will emit evaporative emissions, which will affect the final weight loss calculations.

Relative humidity greater than 20% can bias the permeation results for certain plastics such as nylon. To identify bias due to humidity, relative humidity must be recorded during the test. A trip blank will be tested concurrently to account for moisture uptake.

5. SENSITIVITY AND RANGE

The range of mass measurement of filled fuel tanks for pleasure craft is approximately 20,000 to 450,000 grams depending on fuel tank volume. Scales must have repeatability equal to 10% of the projected weight loss calculated by assuming the permeation rate is equal to the standard.

Example: Scale Repeatability = $3.07 m^2$ X 1.0 g/m^2/day X 10% = 0.31 g.

6. EQUIPMENT

6.1 Use good engineering judgment to seal the fuel tank.

6.2 A top loading balance or strain gauge that meets the requirements above for section 5.

6.3 A vented enclosure with a temperature conditioning system capable of controlling the internal enclosure air temperature to an average tolerance of +/-2.0ºC over the duration of the test. Additionally, the instantaneous temperature shall not exceed +/- 3.0ºC for more than 15 minutes each day of the test. Data confirming this performance shall be recorded at a rate no less than once every 5 minutes.

6.4 A temperature instrument capable of measuring ambient temperature to within +/- 0.2°C.

7. CALIBRATION PROCEDURE

All instruments and equipment used to measure permeation shall be calibrated prior to use per the manufacturer's specifications.

8. DURABILITY DEMONSTRATION

A durability demonstration is required prior to any testing to determine the performance of a fuel tank. Manufacturers must follow durability requirements as described in 33 CFR §183.580 through §183.590.

Following these durability tests, each tank must be preconditioned to ensure a stable permeation rate.

9. PRECONDITIONING PROCEDURE

After performing the durability tests, fill the tank to its nominal capacity with CFGIII fuel. Ensure that all fuel tank outlets are sealed and leak tight using good engineering judgment. This can be accomplished by inserting and clamping metal plugs or by fusion welding a coupon over the fuel outlet(s). Place the fuel tank in a suitable vented enclosure. Record the preconditioning start date on the field data sheet. Soak the tank at 30º C ± 10º C for not less than 140 days. Accelerated preconditioning of the tank can be accomplished by soaking the tank at an elevated temperature. Data documenting that the tank has reached equilibrium must be provided for tanks soaked less than 140 days.

10. SEALING PROCEDURE

After preconditioning, remove the tank from the enclosure to a well-ventilated area. Record the preconditioning end date on the field data sheet. Unseal the fuel tank and empty it. The tank must not remain empty for more than fifteen minutes. Immediately refill the tank to its nominal capacity with CFGIII fuel. Place the unsealed tank in a heated enclosure and allow it to equilibrate to 40º C ± 2º C for a minimum of six hours. After the fuel temperature has equilibrated to 40º C ± 2º C, cap and seal the tank. Perform a leak check by using good engineering judgment.

11. TEST PROCEDURE WITH TRIP BLANK CORRECTION

11.1 Two identical sealed tanks, one containing fuel and one remaining empty, are weighed concurrently. The mass changes documented by the empty tank are used to correct the tank containing fuel due to possible moisture bias. Ensure that the exterior surface of each tank is clean, dry, and free of dirt and debris. Carefully place the full tank on the high capacity balance. Record the initial weight (W_{if}), date, relative humidity, and start time on the field data sheet (Figure 1). Next, carefully place the empty tank on the high capacity balance. Record the initial weight (W_{ie}), date, and start time on the field data sheet.

11.2 Immediately place the two sealed tanks in the enclosure. Begin the 24-hour soak at 40º C $\pm$ 2º C. If more than thirty minutes elapses between the time the sealed tank was weighed and the initiation of the 24-hour soak, then both tanks must be re-weighed.

11.3 At the conclusion of the 24-hour soak period, immediately remove the tanks from the enclosure and ensure that the exterior surface is clean, dry, and free of dirt and debris. Carefully weigh each tank on the high capacity balance. Record the final weights (W_{ff}), (W_{fe}), date, relative humidity, and end time on the field data sheet. If more than thirty minutes elapses between the conclusion of the 24-hour soak period and the final weighing of the sealed tank, the final weight is invalid and should not be used in future calculations. If this occurs, the test procedure must be reinitiated.

11.4 Calculate the difference between the initial weight (W_i) and the final weight (Wf) for each tank. Record the difference on the field data sheet. Refer to Section 14 for calculation.

12. QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Balances used for weighing must be calibrated every six months. In addition, the balances must be checked with mass standards before and after each weighing.

13. RECORDING DATA

Record data on field data sheet as shown in figure 1.

14. CALCULATING PERMEATION RATE USING TRIP BLANK CORRECTION

The daily weight loss in grams is calculated for each 24-hour cycle as follows:

$$Wl = W_{if} - D_f$$

Where:

Wl	=	The weight loss in grams
W_{if}	=	The initial weight of the full tank in grams
W_{ff}	=	The final weight of the full tank in grams
D_f	=	$W_{ff} + D_e$
D_e	=	$W_{ie} - W_{fe}$
W_{ie}	=	The initial weight of the empty tank in grams
W_{fe}	=	The final weight of the empty tank in grams

Plot the cumulative daily weight loss (in grams) against the sampling time (days). Perform a linear regression on ten consecutive data points.

The permeation rate in grams per square meter per day is calculated by dividing the slope of the regression line (grams/day) by the tanks internal surface area (obtained from the tank manufacturer).

$$P_{rate} = Slope / A_{tank}$$

Where:

P_{rate}	=	The permeation rate in grams/meter^2/day
$Slope$	=	The slope of the regression line in grams/day
A_{tank}[1]	=	The tank's internal surface area in meter^2

[1] Report the tank's internal surface area in square-meters to at least two significant figures. The tank internal surfaces are those surfaces that are subjected to fuel liquid or vapor under normal operating conditions and have an opposing surface through the wall section that is in communication with the atmosphere. Internal webs and strengthening structures not in communication with the atmosphere are not considered internal surfaces for the purposes of this testing.

15. ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

16. REFERENCES

Permeation of Gasoline-Alcohol Fuel Blends Through High-Density Polyethylene Fuel Tanks with Different Barrier Technologies, SAE Technical Paper Series 920124, International Congress & Exposition, Detroit Michigan, February 1992

17. FIGURES

Figure 1. Field Data Sheet (Trip Blank Correction)

Figure 1
Field Data Sheet
(Trip Blank Correction)

Tank Manufacturer:_____

Tank I.D:_____

Tested By:_____

Water Bath Test (pass/fail):_____

Tank Internal Surface Area (meter^2):_____

Full Tank Data

Date/Time Start		Date/Time End		Initial Weight W_{if} (grams)	Final Weight W_{ff} (grams)	Difference D_f (grams)	Weight Loss WI (grams)

$WI = (W_{if} - D_f)$, $D_f = (W_{ff} + D_e)$, $D_e = (W_{ie} - W_{fe})$

Empty Tank Data

Date/Time Start		Date/Time End		Initial Weight W_{ie} (grams)	Final Weight W_{fe} (grams)	Difference D_e (grams)	%RH	Baro. Pres.